


ENGINEERING CHANGE NOTICE

Page 1 of 2

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Tank Characterization Report for Single-Shell Tank 241-T-111

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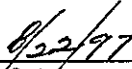
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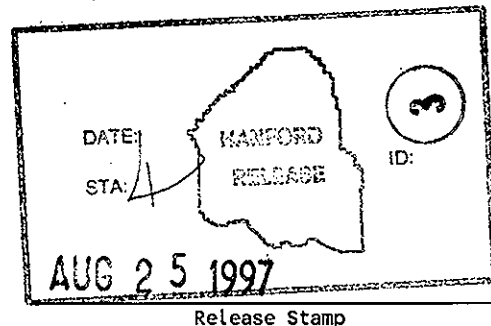
Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-T-111. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.

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Page 1

Tank Characterization Report for Single-Shell Tank 241-T-111

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(6) Cog. Mgr. Date

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3.0 BEST-BASIS INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank wastes is used to perform safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as to address regulatory issues. Waste management activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing the wastes into a form that is suitable for long-term storage.

Chemical inventory information generally is derived using two approaches: 1) component inventories are estimated using the results of sample analyses; and 2) component inventories are predicted using a model based on process knowledge and historical information. The most recent model was developed by Los Alamos National Laboratory (LANL) (Agnew et al. 1997). Not surprisingly, information derived from these two different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as standard characterization information for the various waste management activities (Hodgson and LeClair 1996). Appendix D contains the complete narrative regarding the derivation of the inventory estimates presented in Tables 3-1 and 3-2.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components Tank 241-T-111 (July 2, 1996). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, C or E) ¹	Comment
Al	1,230	S	---
Bi	56,000	S	---
Ca	5,230	S	---
Cl	970	S	Based on analysis of water leach only.
TIC as CO ₃	1,800	S	Based on analysis of water leach only.
Cr	4,230	S	---
F	4,970	S	Based on analysis of water leach only.
Fe	40,000	S	---
Hg	3	S	---
K	2,460	S	---
La	9,120	S	---

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components Tank 241-T-111 (July 2, 1996). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, C or E) ¹	Comment
Mn	13,700	S	---
Na	80,000	S	---
Ni	285	S	---
NO ₂	1,710	S	Based on analysis of water leach only.
NO ₃	89,000	S	Based on analysis of water leach only.
OH	56,200	C	charge balance calculation
Pb	789	S	---
P as PO ₄	68,700	S	---
Si	12,200	S	---
S as SO ₄	7,970	S	---
Sr	648	S	---
TOC	6,800	S	Based on analysis of water leach only.
U _{TOTAL}	6,740	S	Method/sample prep: (Fluorimetry/ Fusion)
Zr	0	M	No sample basis

Notes:

- ¹S = Sample-based, 1991 Core Samples (see Appendix B)
M = Hanford Defined Waste model-based
E = Engineering assessment-based
C = Calculated by charge balance; includes oxides as hydroxides, not including CO₃, NO₂, NO₃, PO₄, SO₄, and SiO₂

Table 3-2. Best-Basis Inventory Estimate for Radioactive, Components in Tank 241-T-111, Decayed to January 1, 1994 (Effective July 2, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M,or E) ¹	Comment
³ H	<DL	S	
¹⁴ C	<DL	S	
⁵⁹ Ni	0.11	S	Method/sample prep: (Acid)
⁶⁰ Co	0.8	S	Method/sample prep: (Fusion)

Table 3-2. Best-Basis Inventory Estimate for Radioactive, Components in Tank 241-T-111, Decayed to January 1, 1994 (Effective July 2, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M,or E) ¹	Comment
⁶³ Ni	12	S	Method/sample prep: (Acid)
⁷⁹ Se	<DL	S	
⁹⁰ Sr	10900	S	Method/sample prep: (Fusion)
⁹⁰ Y	10900	S	based on ⁹⁰ Sr
^{93m} Nb	0.0167	M	
⁹³ Zr	0.0198	M	
⁹⁹ Tc	17	S	Method/sample prep: (Water). Based on analysis of water leach only.
¹⁰⁶ Ru	1.90 E-09	M	
^{113m} Cd	0.0484	M	
¹²⁵ Sb	0.0042	M	
¹²⁶ Sn	0.00627	M	
¹²⁹ I	<DL	S	
¹³⁴ Cs	1.79 E-04	M	
^{137m} Ba	317	S	based on ¹³⁷ Cs
¹³⁷ Cs	334	S	Method/sample prep: (Fusion)
¹⁵¹ Sm	15.5	M	
¹⁵² Eu	0.0176	M	
¹⁵⁴ Eu	0.0813	M	
¹⁵⁵ Eu	1.28	M	
²²⁶ Ra	1.14 E-06	M	
²²⁷ Ac	5.83 E-06	M	
²²⁸ Ra	6.08 E-11	M	
²²⁹ Th	1.18 E-08	M	
²³¹ Pa	1.27 E-05	M	
²³² Th	5.64 E-12	M	
²³² U	6.98 E-06	M	
²³³ U	3.58 E-07	M	
²³⁴ U	0.408	M	
²³⁵ U	0.0182	M	
²³⁶ U	0.00328	M	

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-111, Decayed to January 1, 1994 (Effective July 2, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E) ¹	Comment
²³⁷ Np	8.47 E-04	M	
²³⁸ Pu	0.803	M	
²³⁸ U	0.414	M	
^{239/240} Pu	300	S	Method/sample prep: (Fusion)
²⁴¹ Am	92	S	Method/sample prep: (Fusion)
²⁴¹ Pu	31.4	M	
²⁴² Cm	3.32 E-04	M	
²⁴² Pu	1.41 E-04	M	
²⁴³ Am	2.64 E-07	M	
²⁴³ Cm	6.81 E-06	M	
²⁴⁴ Cm	6.24 E-06	M	

¹S=Sample-based

M=Hanford Defined Waste model-based (Agnew et al. 1997)

E=Engineering assessment-based

APPENDIX D

**EVALUATION TO ESTABLISH BEST-BASIS STANDARD
INVENTORY FOR SINGLE-SHELL TANK 241-T-111**

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS STANDARD INVENTORY FOR SINGLE-SHELL TANK 241-T-111

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available chemical information for tank 241-T-111 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

D1.0 IDENTIFY/COMPILE INVENTORY SOURCES

Characterization results from the most recent core sampling event of the tank solids were originally reported in Revision 0 of the tank 241-T-111 TCR (Simpson 1996) and have been reproduced in this TCR in Section B3.4. Two core samples were obtained and analyzed in 1991. Table B3-5 summarizes the results from the statistical analysis of data from the two core composites, and provides confidence intervals around the mean values. Component inventories can be calculated by multiplying the concentration of an analyte by the current tank volume and by the density of the waste. The HDW model document (Agnew et al. 1996a) provides tank content estimates, derived from the Los Alamos National Laboratory (LANL) model, in terms of component concentrations and inventories. A complete list of data sources used in this evaluation is provided at the end of this section.

D2.0 COMPARE COMPONENT INVENTORY VALUES AND NOTE SIGNIFICANT DIFFERENCES

Sample-based inventories derived from analytical concentration data, and HDW model inventories (Agnew et al. 1996a), are compared in Tables D2-1 and D2-2. (The chemical species are reported without charge designation per the best-basis inventory convention). The tank volume used to calculate the sample-based inventories is 1,688 kL (446 kgal) (Hanlon 1996). This volume is 37.9 kL (10 kgal) less than that reported by Agnew et al. (1996a). Some compaction of the waste and some losses from stabilization have occurred, since the core sampling event in 1991. Consequently, this assessment uses the lower volume. The density used to calculate the sample-based component inventories is 1.28 g/mL, which is the maximum analytically measured value reported in Simpson (1996), but is justified by the

waste compactions. The HDW model density is estimated to be 1.18 g/mL (Agnew et al. 1996a). Note the significant differences between the sample-based and HDW model inventories for several of the bulk components, for example, Ca, Bi, La, Mn, and Sr.

Table D2-1. Sample- and Historical Tank Content-Based Inventory
Estimates for Nonradioactive Components in Tank 241-T-111.

Analyte	Sampling Inventory Estimate ¹ (MT)	HDW Model Inventory Estimate ² (MT)	Analyte	Sampling Inventory Estimate ¹ (MT)	HDW Model Inventory Estimate ² (MT)
Ag	0.28	n/r	NH ₃	n/r	1.44E-05
Al	1.23	n/r	Ni	0.285	0.144
Ba	0.139	n/r	NO ₂	1.71 ³	0.121
Bi	56.0	21.0	NO ₃	89.0 ³	86.0
Ca	5.23	16.1	OH	n/r	70.2
Ce	0.073	n/r	oxalate	n/r	7.71
Cd	0.018	n/r	Pb	0.789	n/r
Cl	0.97	1.16	P as PO ₄	68.7	66.2
Co	0.025	n/r	Sb	0.068	n/r
Cr	4.23	0.398	Si	12.2	1.70
Cu	0.072	n/r	S as SO ₄	7.97	4.58
F	4.97 ³	9.20	Sr	0.648	18.7
Fe	40.0	65.9	TIC as CO ₃	1.8 ³	24.2
Hg	0.003	n/r	TOC	6.74 ³	2.09
K	2.46	1.46	U _{TOTAL}	6.03	0.023
La	9.12	4.48	V	0.031	n/r
Mg	0.814	n/r	Zn	0.23	n/r
Mn	13.7	0.029	H ₂ O (wt%)	76.5	75.9
Na	80.0	94.0	density (kg/L)	1.28	1.18

Notes:

n/r = Not reported

¹Simpson (1996)

²Agnew et al. (1996a)

³Based on analysis of water leach only

Table D2-2. Sample- and Historical Tank Content-based Inventory
Estimates for Radioactive Components in Tank 241-T-111.

Analyte	Sampling Inventory Estimate ¹ (Ci)	HDW model Inventory Estimate ² (Ci)	Analyte	Sampling Inventory Estimate ¹ (Ci)	HDW model Inventory Estimate ² (Ci)
⁹⁰ Sr	11,700	63	¹³⁷ Cs	360	386
⁹⁹ Tc	17 ³	n/r	^{239/240} Pu	300	22
²⁴¹ Am	92	n/r			

Notes:

¹Simpson (1996)

²Agnew et al. (1996a)

³Based on analysis of water leach only.

D3.0 REVIEW AND EVALUATION OF COMPONENT INVENTORIES

The following evaluation of tank contents is performed in order to identify potential errors and/or missing information that would influence the sample-based and HDW model component inventories.

D3.1 CONTRIBUTING WASTE TYPES

Reported Waste Types in Tank 241-T-111

Anderson (1990) and Hill et al. (1995): 2C, 224, DW

Agnew et al. (1996a): 2C, 224

Model-Based Current Inventory (Agnew et al. 1996a)

Waste Type	Waste Vol. kL (kgal)
2C1	526 (139)
2C2	1,064 (281)
224	136 (36)

2C1 = Second decontamination cycle BiPO₄ waste (1944 to 1949).

2C2 = Second decontamination cycle BiPO₄ waste (1950 to 1956).

224 = Waste from final decontamination stage of BiPO₄ process

DW = Wash solution from equipment decontamination at T Plant.

D3.2 EVALUATION OF TECHNICAL FLOWSHEET INFORMATION

Waste compositions from flowsheets for 2C and 224 waste streams are provided in Table D3-1 (from Schneider 1951). The comparative LANL defined waste streams from Agnew et al. (1996a) are also provided in Table D3-1. The 2C defined waste stream in Agnew et al. (1996a) appears to be a "second generation" flowsheet waste stream, derived by Jungfleisch (1984) for an earlier modeling effort. The 224 defined waste in Agnew et al. (1996a) is from Lucas (1989 draft), and is based on the *Bismuth Phosphate Process Technical Manual* (GE 1944). The flowsheet information from Schneider (1951) for 2C and 224 waste is based on actual processing history from 1944 to 1951, and thus is considered a better approximation of flowsheet conditions than those provided in (GE 1944).

Table D3-1. Technical Flowsheet and Los Alamos National Laboratory Defined Waste Streams.

Analyte	Flowsheet 2C ¹ (M)	HDW model 2C2 ² (M)	Flowsheet 224 ³ (M)	HDW Model 224 ³ (M)
NO ₃	0.988	0.693	1.06	1.58
NO ₂	NR	0	0	0
SO ₄	0.060	0.0269	0.0014	0.0016
Bi	0.00623	0.0053	0.00595	0.0062
Fe	0.030	0.0286	0	0.016
Si	0.0257	0.0195	0	0
U	2.4E-05	5.4E-05	0	0
Cr ^{3+/6+}	0.00123	0.00541	0.00362	0.0041
PO ₄	0.241	0.110	0.0322	0.0492
F	0.154	0.116	0.272	0.310
Na	1.59	1.27	1.62	1.80
K	0	0.0037	0.223	0.271
La	0	0	0.00376	0.015
Mn	0	0	0.00514	0.005
C ₂ O ₄ ⁻²	0	0	0.0459	0.03

Notes: ¹Schneider (1951)

²Appendix B of Agnew et al. (1996a).

³Appendix B of Agnew et al (1996a)

D3.3 ASSUMPTIONS FOR RECONCILING WASTE INVENTORIES

Because of the major differences in the analytical based inventories and the inventories estimated in the HDW model (Agnew et al. 1996a) reference inventories were estimated using an independent assessment that is based on a set of simplified assumptions. The predicted inventories were then compared with the sample-based inventories and the HDW model inventories. The assumptions and observations were based on best technical judgement pertaining to input information that can significantly influence tank inventories. This includes: (1) prediction of contributing waste types, correct relative proportions of the waste types, (2) predictions of flowsheet conditions, fuel processed, and waste volumes, (3) prediction of component solubilities, and (4) predictions of physical parameters such as density and percent solids. By using this evaluation, the assumptions can be modified as necessary to provide a basis for identifying potential errors and/or missing information that could influence the sample- and model-based inventories. Following are the simplified assumptions and observations used for the evaluation.

1. The 2C and 224 waste streams contributed to solids formation. The relative proportions of 224 waste to 2C waste used for comparison, were, respectively 25:75 based on analytical data (see Section D3.4). This compares to 8:92 based on Appendix D of Agnew et al. (1996a). Using the 25:75 basis, the respective volumes of 224 and 2C waste on tank 241-T-111 are 416 kL (110 kgal) and 1,270 kL (336 kgal).
2. Components listed in the process flowsheets from Schneider (1951) were used for the evaluation (see Table D3-1).
3. Tank waste mass is calculated using the tank volume listed in Hanlon (1996). Both the analytical-based and the model-based inventories are derived using volumes that are quite comparable (that is, 1,688 kL [446 kgal] from Hanlon [1996] and 1,730 kL [458 kgal] from Agnew et al. [1996]). As a result, inventory comparisons are made on essentially the same mass/volume basis.
4. Tanks 241-B-201 and 241-B-110, which contain only one waste type (224 and 2C, respectively) helped provide the analytical basis for inventories for the 224 and 2C waste types.
5. No radiolysis of NO_3 to NO_2 and no additions of NO_2 to the waste for corrosion control are factored into this assessment.
6. All Bi, Fe, Mn, Si, and U precipitate as water insoluble components. These assumptions are based on the known chemistry of the components in alkaline solutions. The HDW model predicts varying solubilities for the components.

7. All Na, K, NO₃, NO₂, and C₂O₄ remain dissolved in the interstitial liquid associated with the solids.
8. La, PO₄, SO₄, Cr, and F partition between the liquid and solid phases based on known chemical solubilities and properties of compounds in alkaline solutions.
9. Interstitial liquid is a composite of all wastes. Contributions of dissolved components are weighted by volume: 2C - 0.75 and 224 - 0.25
10. Concentrations of components in interstitial liquid are based on a void fraction of 0.8.

D3.4 VOLUME RATIO 224 WASTE:2C WASTE

The HDW model predicts 136 kL (36 kgal) 224 waste and 1,590 kL (420 kgal) 2C waste in tank 241-T-111. Analytical information indicates that the 224 waste comprises a much larger portion of the total waste. The relative contributions of 224 waste and 2C waste can be estimated by determining the concentrations of chemical constituents in tank 241-T-111 that are found only in one of the contributing waste types. Only 224 waste contains lanthanum, potassium, and manganese, and only 2C waste contains iron and silicon.

One simple method to determine the relative proportions of waste is to compare average analytical based concentrations for like waste types. The average reported analytical value is 0.053 MT La/kgal of 224 waste in tank 241-B-201 (Heasler et al. 1993). Simpson (1996) reports 9.2 MT La in tank 241-T-111 or 0.02 MT La/kgal of tank 241-T-111 waste.

$$\text{Thus: } \frac{0.02 \text{ MT/kgal 241-T-111}}{0.071 \text{ MT/Kgal 224 Waste}} = 0.28$$

or 28 percent by volume 224 waste and 72 percent by volume 2C waste.

Similarly, the reported value for Mn in tank 241-B-201 waste based on analytical data is 0.091 MT/kgal (Heasler et al. 1993) and the reported value for Mn in tank 241-T-111 is 0.03 MT/kgal.

$$\text{Thus: } \frac{0.030 \text{ MT/kgal 241-T-111}}{0.091 \text{ MT/kgal 241-B-201}} = 0.33$$

Another way to estimate the proportions and volumes of 2C and 224 waste in tank 241-T-111 is to predict the concentrations or masses of solid waste components that would be transferred to the tank based on the assumed 2C and 224 flowsheets for the bismuth phosphate process.

The predicted values can then be compared to concentrations or masses of tank components determined by sample analysis. The Schneider (1951) flowsheet

Table D3-1 indicates 0.00514 moles Mn/L of 224 waste. If the assumption is that tank 241-T-111 contains only 224 waste, a total of 43 MT of Mn would be predicted for the solids. Based on the assumptions previously listed:

$$0.00514 \text{ moles Mn/L} \times 446 \text{ kgal} \times 3,785 \text{ L/kgal} \times 90_{CF} \times 54.9 \text{ g/mole Mn} \times \text{MT}/1.0\text{E}+06\text{g} = 43 \text{ MT Mn}$$

* See Section D3.5 for estimation of CF.

The analytical-based value for Mn in tank 241-T-111 is 13.6 MT.

$$\text{Thus: } [13.6 \text{ MT}_{\text{Mn}}/43\text{MT}_{\text{Mn}}]100 = 32 \text{ percent of predicted value for Mn, or ratio 224:2C is 32:68.}$$

The ratio of 224:2C waste can also be estimated based on potassium, which is expected to remain dissolved in the interstitial liquid associated with the solids.

$$\text{Thus: } 0.223 \text{ moles K/L} \times 446 \text{ kgal} \times 3,785 \times 0.8_{\text{porosity}} \times 39 \text{ g/mole K} \times \text{MT}/1.0\text{E}+6\text{g} = 12.1 \text{ MT K if all 446 kgal were 224 waste}$$

Because the analysis for K in tank 241-T-111 shows 2.5 MT (Table D3-1)

$$\frac{2.5 \text{ MT}}{12.1 \text{ MT}} = 0.2$$

or approximately 20 percent 224 and 80 percent 2C waste.

Similar calculations based on Si (unique to 2C waste) indicate a ratio of 224:2C of approximately 25:75.

A volume ratio of 25:75 for 224 2C waste is used in this evaluation based on the above estimates. This basis is equivalent to approximately 416 kL (110 kgal) of 224 waste, and 1,270 kL (336 kgal) of 2C waste in tank 241-T-111.

D3.5 SOLIDS CONCENTRATION FACTOR FOR 224 AND 2C WASTE IN TANK 241-T-111

One method of estimating the concentration of a component in 2C or 224 waste solids in tank 241-T-111 is to determine the concentration factor (CF) for that component. The CF is

defined as the ratio of the concentration of components in solids fully precipitated from solution versus the concentration of that component in the neutralized waste stream. The CF has an inverse relationship with the volume percent solids in a defined waste stream, for example, the CF for precipitated components in 224 waste based on Agnew et al. (1996a) is $1 \div 3.9 \text{ vol\% solids (100)} = 25.6$. It was noted earlier that this evaluation assumed Bi and other flowsheet components to be 100 percent precipitated. Bismuth can be used to determine what the CF is for both 224 and 2C waste in tank 241-T-111. This is accomplished by determining what CF would be necessary to bring the waste stream concentration multiplied by the total waste volume into agreement with sampling data. This biases the data towards the sampling results. If this CF is used for the other fully precipitated analytes and the results agree with the sampling data (that is, the CFs are nearly the same for components expected to fully precipitate), then it can be assumed that sampling data are consistent with the flowsheet basis and are quite representative of the tank contents.

The first step is to estimate the approximate CF for the two waste streams in tank 241-T-111. One method is to determine the CF for 224 and 2C waste for tanks that contain only those unique waste types (that is, tanks 241-B-201 and 241-B-110 respectively). The CFs are often consistent for the same waste type in different tanks. Schneider (1951) shows a concentration for Bi in neutralized 224 waste as 0.00595 mol/L (also see Table D3-3). The concentration for Bi in tank 241-B-201, which contains only 224 waste, is 0.565 moles Bi/L and the tank contains 13 MT Bi (Heasler et al. 1993). For 224 waste in tank 241-B-201 the CF can then be estimated:

$$\frac{0.565 \text{ moles Bi/L}}{0.00595 \text{ moles Bi/L}} = 95$$

An alternate method for calculation is:

$$0.00595 \text{ moles Bi/L} \times 29 \text{ kgal}_{\text{B-201}} \times 3,785 \text{ L/kgal} \times 209 \text{ g Bi/mole} \times \text{MT}/1.0\text{E}+06 \times \text{CF} = 13 \text{ MT}$$

$$\text{or } 0.136 \text{ MT} \times \text{CF} = 13 \text{ MT}$$

$$\text{Thus: CF} = 95$$

By assuming the composition of 224 waste in tank 241-B-201 is comparable to 224 waste in tank 241-T-111, the same CF can be used for 224 waste in both tanks.

Using similar calculations from Heasler et al. (1993) for tank 241-B-201 and Table D3-1 for 224 waste, a CF of 85 is obtained based on Mn, which is the only other component in 224 waste expected to fully precipitate. For this evaluation an average CF of 90 is used for components that precipitate because this is consistent with the CF used for reconciliation of tank 241-B-201 and it results in inventories that are very consistent with analytical data.

Note: Lanthanum is also expected to fully precipitate, but will likely have partitions between aqueous and solid phases because the CF for La is approximately 50. This could indicate conversion to other forms resulting from metathesis dissolution of the LaF_3 precipitate upon aging of the waste (see Section D3.6).

For 2C waste Bi, Fe, and Si are expected to fully precipitate. The CF for these components is estimated by comparison with analysis of Bi, Fe, and Si in tank 241-B-110 (Amato et al. 1994) which contains essentially all 2C waste solids. The CF for Bi in tank 241-B-110 is:

$$\frac{0.136 \text{ moles Bi/L}}{0.00623 \text{ moles Bi/L}} = 22$$

Alternatively the CF can be determined as follows:

$$0.00623 \times 245^* \text{ kgal}_{\text{B-110}} \times 3,785 \text{ L/kgal} \times 209 \text{ g Bi/mole} \times \text{MT}/1.0\text{E}+06 \text{ g} \times \text{CF} = 26.4^* \text{ MT}$$

$$\text{or } 1.207 \text{ MT} \times \text{CF} = 26.4 \text{ MT}$$

$$\text{Thus: CF} = 22$$

* Noted values are from analytical data for tank 241-B-110 (Amato et al. 1994).

Based on additional comparisons of analytical data from Amato et al. (1994) for tank 241-B-110 and flowsheet values from Table D3-1, the CF for Si and Fe is 17 and 23, respectively.

Another approach can be used for determining the CF for precipitated components in tank 241-T-111 if: (1) the source of the component in the tank is from only one of the waste types (for example, Mn from 224 waste), and (2) the volume of that waste type in the tank can be reasonably estimated. This approach is valuable because the CF for a component in a particular waste type may not necessarily be comparable for different tanks due to the large variation in waste volumes flushing through the tanks and variations in solids: liquid ratios resulting from cascading and cribbing procedures. For example as just shown, the CF for Si in 2C waste based on tank 241-B-110 is 18.5. The CF for Si in tank 241-T-111 is only 13.4 based on the flowsheet Si concentration in 2C waste from Table D3-1, an assumed 1,270 kL (336 kgal) of 2C waste in tank 241-T-111, and a calculated (sample-based) mass of 12.3 MT Si in tank 241-T-111 (Simpson 1996).

$$\text{Thus: } 0.0257 \text{ moles Si/L} \times 336 \text{ kgal}_{\text{T-111}} \times \text{CF} \times 3,785 \text{ L/kgal} \times 28.09 \text{ g/mole Si} \times \text{MT}/1.0\text{E}+06 = 12.3 \text{ MT Si}$$

$$\text{or } 0.918 \text{ MT} \times \text{CF} = 12.3 \text{ MT}$$

$$\text{CF} = 13.4$$

For this evaluation, an average CF of 15 was used for components in 2C waste. This CF, which is based on the calculated values just described, results in predicted inventories that are very consistent with those obtained from analytical data for tank 241-T-111.

D3.6 ESTIMATE OF PARTITIONING FACTORS FOR COMPONENTS ASSUMED TO PARTITION BETWEEN AQUEOUS AND SOLID PHASES

Some waste components are partially water soluble. The relative concentration of these components in both the solids and the aqueous phase is called the partitioning factor (PF). The PF for 224 waste components have been determined based on the inventory reconciliation process for tank 241-B-201, which contains only 224 waste. Similar PFs can be assumed approximately the same for 224 waste in other tanks (for example, tank 241-T-111) that also contain 224 waste as well as other waste types. As mentioned earlier, component concentrations in a particular waste type may not be exactly comparable due to the large variation in the waste volumes flowing through the tanks, variations in solids and liquid ratios resulting from cascading and cribbing procedures, and also because of potential for chemical reactions (for example, metathesis) of components when mixed/diluted with other waste types.

Partition factors are approximated by comparing the CF for a component in a waste type (for example, 224) with the concentration factor for a constituent known to fully precipitate (for example, Bi with CF of 22). Thus for tank 241-B-110 (all 2C waste) the phosphate PF is based on the CF for PO_4 in tank 241-B-110 (Amato et al. 1994).

$$\text{Thus: } 0.241 \text{ moles } \text{PO}_4/\text{L} \times 245 \text{ kgal}_{\text{B-110}} \times 3,785 \text{ L/kgal} \times 95 \text{ g/mole } \text{PO}_4 \times \text{MT}/1.0\text{E}+06 \times \text{CF} = 95 \text{ MT } \text{PO}_4$$

$$\text{or } 21.2 \text{ MT} \times \text{CF} = 95 \text{ MT}$$

$$\text{CF} = 4.5$$

$$\text{Thus: the PF for } \text{PO}_4 \text{ (241-B-110)} = \frac{4.5 \text{ CF}}{22.0 \text{ CF}} = 0.20$$

Using this method, the estimated PF for other components in 2C waste based on tank 241-B-110 are:

$$\begin{array}{ll} \text{Cr:} & 1.0 \\ \text{SO}_4: & 0.1 \\ \text{F:} & 0.04 \end{array}$$

For 224 waste the fraction partitioned to solids for La, PO₄, SO₄, and F is as follows based on tank 241-B-201.

La: 0.5
 Cr: 0.3
 PO₄: 0.05
 SO₄: 0.1
 F: 0.01

The preceding examples provide approximations for determining inventories in other tanks that contain 2C waste. It may be found by trial and error (as above) that a better fit to the analytically derived data may require some adjustments to these estimated partition factors.

D3.7 ESTIMATED INVENTORY OF COMPONENTS

The following calculations provide estimates of tank 241-T-111 inventories. As previously described, a CF (based on Bi) of 90 is used for 224 waste and 15 for 2C waste.

Components Assumed to Precipitate 100 Percent (Bi, Mn, Si, Fe, and U)

Bi: $[0.00623 \text{ moles Bi/L}_{2C} \times 336 \text{ kgal} \times 15_{CF(2C)} + 0.00595 \text{ moles Bi/L}_{224} \times 110 \text{ kgal} \times 90_{CF(224)}] \times [3,785 \text{ L/gal} \times 209 \text{ g/mole Bi} \times \text{MT}/1\text{E}+06\text{g}] = 71 \text{ MT}$

Mn: $0.00514 \text{ moles Mn/L}_{224} \times 110 \text{ kgal} \times 90_{CF(224)} \times 3,785 \text{ L/gal} \times 54.9 \text{ g/mole Mn} \times \text{MT}/1\text{E}+06\text{g} = 10.6 \text{ MT}$

Si: 14 MT
 Fe: 32 MT
 U: 0.11 MT

Components Assumed to Remain Dissolved in Interstitial Liquid (Na, NO₃, NO₂, C₂O₄, K)

NO₃: $[0.99 \text{ moles}_{NO_3}/L_{2C} \times 336 \text{ kgal} + 1.06 \text{ moles}_{NO_3}/L_{224} \times 110 \text{ kgal}] \times 3,785 \text{ L/kgal} \times 0.8_{\text{porosity}} \times 63 \text{ g/mole}_{NO_3} \times \text{MT}/1\text{E}+06\text{g} = 86 \text{ MT}$

NO₂: 0 MT
 Na: 50 MT
 K: 2.9 MT
 C₂O₄: 1.3 MT

Components Assumed to Partition Between Aqueous and Solid Phases (La, PO₄, Cr, SO₄, F)

La: $0.00376 \text{ moles La/L} \times 110 \text{ kgal} \times 3,785 \text{ L/kgal} \times 139 \text{ g/mole}_{\text{La}} \times 90 \text{ CF} \times 0.5 \text{ PF} \times \text{MT}/1.0\text{E}+6\text{g} = 9.8 \text{ MT}$

Cr: $(0.00123 \text{ moles Cr/L} \times 336 \text{ kgal}_{2\text{C}} \times 3,785 \text{ L/kgal} \times 52 \text{ g/mole}_{\text{Cr}} \times 15 \text{ CF} \times \text{MT}/1.0\text{E}+6\text{g}) + (0.00362 \text{ moles Cr/L} \times 110 \text{ kgal}_{224} \times 3,785 \text{ L/kgal} \times 52 \text{ g/moles}_{\text{Cr}} \times 90 \text{ CF} \times 0.3 \text{ PF} \times \text{MT}/1.0\text{E}+6\text{g}) = 3.3 \text{ MT}$

PO₄: $(0.0323 \text{ moles PO}_4\text{/L} \times 110 \text{ kgal}_{224} \times 3,785 \text{ L/kgal} \times 95 \text{ g/mole}_{\text{PO}_4} \times 90 \text{ CF} \times 0.05 \text{ PF} \times \text{MT}/1.0\text{E}+6\text{g}) + (0.241 \text{ moles PO}_4\text{/L} \times 336 \text{ kgal}_{2\text{C}} \times 3,785 \text{ L/kgal} \times 95 \text{ g/moles}_{\text{PO}_4} \times 15 \text{ CF} \times 0.20 \text{ PF} \times \text{MT}/1.0\text{E}+6\text{g}) = 93 \text{ MT}$

F: The PFs for 224 (0.01) and for 2C (0.04) from Section D3.6 were not used for F for tank 241-T-111. The assumption that the F remained entirely in interstitial liquid provided for best fit with analytical data.

$(0.154 \text{ moles F/L} \times 336 \text{ kgal}_{2\text{C}} \times 3,785 \text{ L/kgal} \times 19 \text{ g/mole}_{\text{F}} \times 0.8_{\text{porosity}} \times \text{MT}/1.0\text{E}+6\text{g}) + (0.272 \text{ moles F/L} \times 110 \text{ kgal}_{224} \times 3,785 \text{ L/kgal} \times 19 \text{ g/mole}_{\text{F}} \times 0.8_{\text{porosity}} \times \text{MT}/1.0\text{E}+6\text{g}) = 4.7 \text{ MT}$

SO₄: The PFs for 224 (0.1) and for 2C (0.1) from Section D3.6 were not used for SO₄ for tank 241-T-111. The assumption that all SO₄ remained in interstitial liquid provided best fit with analytical data.

$0.0602 \text{ moles SO}_4\text{/L} \times 336 \text{ kgal}_{2\text{C}} \times 3,785 \text{ L/kgal} \times 96 \text{ g/mole}_{\text{SO}_4} \times 0.8_{\text{porosity}} \times \text{MT}/1.0\text{E}+6\text{g} + 0.0014 \text{ moles SO}_4\text{/L} \times 110 \text{ kgal}_{224} \times 3,785 \text{ L/kgal} \times 96 \text{ g/mole}_{\text{SO}_4} \times 0.8_{\text{porosity}} \times \text{MT}/1.0\text{E}+6\text{g} = 5.9 \text{ MT}$

Estimated component inventories from this evaluation are compared with sample and HDW model-based inventories in Table D3-2. Conclusions and observations regarding these inventories are noted, by component, in the following text.

Table D3-2. Comparison of Selected Component Inventory Estimates for Tank 241-T-111 Waste.

Component	This Evaluation (MT)	Sample-based (MT)	HDW Model (MT)
Bi	71	56.0	21.0
Cr	3.3	4.23	0.398
Fe	32	40.0	65.9

Table D3-2. Comparison of Selected Component Inventory Estimates for Tank 241-T-111 Waste.

Component	This Evaluation (MT)	Sample-based (MT)	HDW Model (MT)
K	2.9	2.46	1.46
La	9.9	9.12	4.48
Mn	10.6	13.7	0.029
Na	50	80.0	94.0
Si	13.8	12.2	1.70
Sr	n/r	0.648	18.7
U	0.11	6.03	0.023
F	4.7	4.97 ¹	9.20
NO ₃	86	89.0 ¹	86.0
NO ₂	n/r	1.71 ¹	0.121
PO ₄	93	68.7	66.2
SO ₄	5.9	7.97	4.58
H ₂ O (%)	---	76.5	75.9

Notes: ¹Based on analysis of water leach only.
n/r = not reported

Bismuth. The reference inventory predicted by this assessment and the sample-based inventory are both significantly higher than the HDW model inventory. The HDW Model inventory reflects the assumptions that only 60 percent, 24 percent, and 35 percent, respectively, of the bismuth in the 2C1 stream, 2C2 stream, and 224 stream precipitated. This basis resulted in a significant amount of bismuth being cascaded to cribs based on the HDW model. The predicted inventory of 71 MT is 25 percent higher than the analytical-based inventory which could be the result of the following, or a combination of the following: (1) the ratio of 2C:224 waste may be closer to 80:20 than 75:25 and (2) somewhat less of the bismuth precipitated than the 100 percent assumed for this assessment. As noted, Bi was used to determine the CF for this waste tank.

Chromium. This inventory assessment predicted the total chromium content to be reasonably close to that based on sample analysis. These values are approximately 10-fold higher than that predicted by the HDW model. The HDW model defined waste streams indicate higher concentrations of chromium in the 2C and 224 wastes than given in Schneider (1951) (Table

D3-2). These concentrations may be inflated somewhat from the corrosion source-terms assumed for the HDW model while no corrosion source term was used in this assessment. The HDW model assumes that none of the chromium precipitated in the 2C and 224 streams that is, the only chromium contribution to the solids is from the interstitial liquids associated with the solids. For this assessment, the assumption that a considerable amount of chromium precipitated is substantiated by the close match with analytical results for the pure waste types (224 waste-tank 241-B-201, and 2C waste-tank 241-B-110) and is corroborated by the analytical data for tank 241-T-111. Additionally, because the chromium was added primarily as chromium (III) in the BiPO_4 process, it is expected that the majority of the chromium will precipitate as $\text{Cr}(\text{OH})_3$ or $\text{Cr}_2\text{O}_3 \cdot \text{XH}_2\text{O}$.

Iron. The reference iron inventory predicted by this assessment and the sample-based inventory are both smaller than for the HDW model inventory. This evaluation does not include a corrosion source-term for iron, which may explain the smaller inventory for this assessment. The HDW model inventory prediction may be biased high based on a corrosion source-term for iron that is considered high. The difference between the measured (analytical) and calculated (this assessment) iron concentrations does not suggest a large corrosion source term.

Potassium. The reference potassium inventory predicted by this assessment and the sample-based inventory are both approximately twice that predicted by the HDW model. This is primarily due to the predicted small contribution of the 224 waste stream (8 vol%) by the HDW model for this tank versus the 25 percent contribution predicted by this assessment.

Lanthanum. The reference lanthanum inventory predicted by this assessment is close to the sample-based inventory, however, both are approximately twice that predicted by the HDW model. This assessment and the HDW model both predict approximately 50 percent of the lanthanum to precipitate. The contribution of the 224 waste stream that contains lanthanum is predicted to be only 8 vol% by the HDW model versus 25 vol% by this assessment.

Manganese. The manganese inventory predicted by this assessment is slightly lower than the sample-based inventory but both are much higher than the inventory projected by the HDW model. It is possible that the sample reflects some contribution of manganese for T Plant decontamination operations in addition to the manganese from the 224 process. Based on known chemistry of manganese in alkaline solution, this assessment predicted that all of the manganese in 224 waste will precipitate. The HDW model assumes that none of the manganese will precipitate from the 224 waste streams; that is, the only manganese contribution in the solids for the HDW model is from the interstitial liquids. Additionally, the HDW model predicts that the 224 waste contributes only 8 percent of the waste volume, as opposed to 25 percent predicted by this independent assessment.

Sodium. The sodium inventory predicted by this evaluation is lower than the sample-based inventory. The evaluation assumed that sodium would not partition to the solids. Some slight partitioning probably occurs, however the HDW model over predicts any partitioning that may

occur. Sodium partitioning does not appear to be straight forward and more study should be applied to it. The sample analytical data appears to be the best estimate.

Silicon. The reference silicon inventory predicted by this assessment compares quite well with the sample-based inventory, but is approximately eight times that predicted by the HDW model. The apparent explanation is that this assessment assumes that all silicon precipitates while the HDW model assumes a significant portion of the silicon is in the aqueous stream that is sent to cribs.

Strontium. Based on BiPO_4 flowsheets (Schneider 1951) strontium (nonradioactive) was not added as a process chemical. This assessment predicts no strontium in tank 241-T-111 although some contribution will enter the tank as fission product (^{89}Sr , ^{90}Sr) as well as from contaminants in process chemicals. The sample analysis predicts a small amount (approximately 600 kg) of strontium. The HDW model predicts 18,700 kg (18.7 MT) with the source being attributed to 0.063M $\text{Sr}(\text{NO}_3)_2$ in the 224 defined waste stream. No documentation shows that strontium was added as a process chemical in the 224 flowsheet (Schneider 1951). However, $\text{Sr}(\text{NO}_3)_2$ was added as a scavenging agent to precipitate ^{90}Sr from uranium recovery waste, first-cycle decontamination wastes from T Plant, and in-farm wastes. Based on these flowsheets, the $\text{Sr}(\text{NO}_3)_2$ should be indicated as a process chemical in the ferrocyanide wastes defined in the HDW model rather than 224 waste.

Fluoride. The inventory predicted by this assessment and the sample-based inventory are nearly identical. This assessment assumed that none of the fluoride in the tank remains as insoluble compounds, that is, all is associated with the interstitial liquors. The analytical-based inventory results from analysis of the aqueous portion generated from water leaching of the sample. Both of these evaluations are about half of the inventory predicted by the HDW model. The water insoluble solids may contain fluoride, but it is not possible to determine how much until an analytical method that measures total fluoride is utilized. This assessment may therefore, significantly underestimate the fluoride content of this tank even though it matches the analytical data. The HDW model assumes that a portion of the fluoride is present in the solids as NaF although this compound should be measured by the water digestion analytical method.

Nitrate. The nitrate inventories predicted by this assessment, by the HDW model, and by sample analysis are all comparable. Both the HDW model and this evaluation assume all nitrate to remain in the aqueous. A larger nitrate inventory could be possible if the solids contain any water insoluble phase such as cancrinite, which could not dissolve in a water digestion analysis.

Nitrite. This assessment does not account for any nitrite from radiolysis of nitrate or any nitrite additions for corrosion purposes. The sample analysis and the HDW model predict only small inventories of nitrite.

Phosphate. The phosphate inventory predicted by this assessment is approximately 40 percent higher than that predicted by both the HDW model and sample analyses. As noted earlier, the assumptions used in this assessment for partitioning the phosphate between solid and aqueous phases are based on calculated PF for tanks that contain only 224 and 2C waste (that is, tanks 241-B-201 and 241-B-110, respectively). For reasons explained earlier, the PF for components with mixed waste types may vary. The analytical and HDW model bases may provide the best estimates for phosphate for this tank.

Sulfate. The HDW inventory is slightly smaller than the sample-based inventory, as is the inventory estimated by this evaluation. Both this assessment and the HDW model assumed that the sulfate partitions entirely to the aqueous phase. As shown earlier, based on analyses of tanks 241-B-110 and 241-B-201, some sulfate does partition to the solid phase. Thus, by adjusting the PF for sulfate to approximately 0.01 (only one percent partitioning to the solid phase) this assessment would predict a sulfate inventory very close to that based on the sample analysis.

Uranium. The sample analysis indicates the uranium inventory to be much larger than the independent assessment and the HDW model predict. The sample basis is considered valid because consistent analytical results for the core samples were obtained from two independent laboratories. The source of the uranium cannot be identified. Both process flowsheets and waste transaction information indicate that only minor amounts of uranium should be in the waste.

Total Hydroxide. Once the best basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments the number of significant figures is not increased. This charge balance approach was consistent with that used by Agnew et al. (1996).

D4.0 BEST-BASIS INVENTORY ESTIMATE

The results from this evaluation support using the sampling data as the basis for the best estimate inventory to tank 241-T-111 for the following reasons:

1. Data from two core composite samples were used to estimate the component inventories. The core sample recovery was quite complete.
2. With the exception of PO_4 and U, results from this evaluation compares favorably with the sample-based results.
3. The inventory estimate generated by the HDW model is based on a predicted 2C:224 waste volume ratio 92:8, whereas sample analyses of components that are unique to these two waste types indicate a higher contribution of 224 waste, for example, 80:20 or 75:25.
4. The fraction precipitated basis used for the independent analysis for major components result in inventory estimates that compare favorably with sample analyses. The concentration factors calculated for fully precipitated components (for example, Bi) were based on comparing flowsheet concentrations with analytical-based concentrations. The relative concentrations of components in the waste solids are consistent with those expected for waste resulting from BiPO_4 process 2C and 224 process flowsheets. For nearly all components, the calculated CF and PF resulted in inventories that are consistent with the predicted chemical behaviors of the components in alkaline media.
5. The flowsheet bases and waste volumes used for this assessment are believed to reflect the processing conditions more closely than those that govern the HDW model inventories.

Best-basis inventory estimates for tank 241-T-111 are presented in Tables D4-1 and D4-2. Component inventories are rounded to two significant figures. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr , ^{137}Cs , $^{239/240}\text{Pu}$, and total uranium, or (total beta and total alpha) while other key radionuclides such as ^{60}Co , ^{99}Tc , ^{129}I , ^{154}Eu , ^{155}Eu , and ^{241}Am , etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997.) Model

generated values for radionuclides in any of 177 tanks are reported in the Hanford Defined Waste Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Best-basis tables for chemicals and only four radionuclides (^{90}Sr , ^{137}Cs , Pu and U) were being generated in 1996, using values derived from an earlier version (Rev. 3) of the Hanford Defined Waste model. When values for all 46 radionuclides became available in Rev 4 of the HDW model, they were merged with draft best-basis chemical inventory documents. Defined scope of work in FY 1997 did not permit Rev. 3 chemical values to be updated to Rev. 4 chemical values.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components
Tank 241-T-111 (July 2, 1996). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, C or E) ¹	Comment
Al	1,230	S	---
Bi	56,000	S	---
Ca	5,230	S	---
Cl	970	S	Based on analysis of water leach only.
TIC as CO ₃	1,800	S	Based on analysis of water leach only.
Cr	4,230	S	---
F	4,970	S	Based on analysis of water leach only.
Fe	40,000	S	---
Hg	3	S	---
K	2,460	S	---
La	9,120	S	---
Mn	13,700	S	---
Na	80,000	S	---
Ni	285	S	---
NO ₂	1,710	S	Based on analysis of water leach only.
NO ₃	89,000	S	Based on analysis of water leach only.
OH	56,200	C	charge balance calculation

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components
 Tank 241-T-111 (July 2, 1996). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, C or E) ¹	Comment
Pb	789	S	---
P as PO ₄	68,700	S	---
Si	12,200	S	---
S as SO ₄	7,970	S	---
Sr	648	S	---
TOC	6,800	S	Based on analysis of water leach only.
U _{TOTAL}	6,740	S	Method/sample prep: (Fluorimetry/ Fusion)
Zr	0	M	No sample basis

Notes:

- ¹S = Sample-based, 1991 Core Samples (see Appendix B)
 M = Hanford Defined Waste model-based
 E = Engineering assessment-based
 C = Calculated by charge balance; includes oxides as hydroxides, not including CO₃, NO₂, NO₃, PO₄, SO₄, and SiO₃

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-111, Decayed to January 1, 1994 (Effective July 2, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M,or E) ¹	Comment
³ H	<DL	S	
¹⁴ C	<DL	S	
⁵⁹ Ni	0.11	S	Method/sample prep: (Acid)
⁶⁰ Co	0.8	S	Method/sample prep: (Fusion)
⁶³ Ni	12	S	Method/sample prep: (Acid)
⁷⁹ Se	<DL	S	
⁹⁰ Sr	10900	S	Method/sample prep: (Fusion)
⁹⁰ Y	10900	S	based on ⁹⁰ Sr
^{93m} Nb	0.0167	M	
⁹³ Zr	0.0198	M	
⁹⁹ Tc	17	S	Method/sample prep: (Water). Based on analysis of water leach only.
¹⁰⁶ Ru	1.90 E-09	M	
^{113m} Cd	0.0484	M	
¹²⁵ Sb	0.0042	M	
¹²⁶ Sn	0.00627	M	
¹²⁹ I	<DL	S	
¹³⁴ Cs	1.79 E-04	M	
^{137m} Ba	317	S	based on ¹³⁷ Cs
¹³⁷ Cs	334	S	Method/sample prep: (Fusion)
¹⁵¹ Sm	15.5	M	
¹⁵² Eu	0.0176	M	
¹⁵⁴ Eu	0.0813	M	
¹⁵⁵ Eu	1.28	M	
²²⁶ Ra	1.14 E-06	M	
²²⁷ Ac	5.83 E-06	M	
²²⁸ Ra	6.08 E-11	M	
²²⁹ Th	1.18 E-08	M	
²³¹ Pa	1.27 E-05	M	
²³² Th	5.64 E-12	M	
²³² U	6.98 E-06	M	
²³³ U	3.58 E-07	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-111, Decayed to January 1, 1994 (Effective July 2, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M,or E) ¹	Comment
²³⁴ U	0.408	M	
²³⁵ U	0.0182	M	
²³⁶ U	0.00328	M	
²³⁷ Np	8.47 E-04	M	
²³⁸ Pu	0.803	M	
²³⁸ U	0.414	M	
^{239/240} Pu	300	S	Method/sample prep: (Fusion)
²⁴¹ Am	92	S	Method/sample prep: (Fusion)
²⁴¹ Pu	31.4	M	
²⁴² Cm	3.32 E-04	M	
²⁴² Pu	1.41 E-04	M	
²⁴³ Am	2.64 E-07	M	
²⁴³ Cm	6.81 E-06	M	
²⁴⁴ Cm	6.24 E-06	M	

¹S=Sample-based

M=Hanford Defined Waste model-based (Agnew et al. 1997)

E=Engineering assessment-based

D5.0 APPENDIX D REFERENCES

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